ATTACHMENT 1 – FLOOD AND SEDIMENT ANALYSES OF BIG CREEK WATERSHED, JEFFERSON PROVING GROUNDS, INDIANA

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Introduction

This report presents the development and analysis of flood flows and suspended sediment transport and yield from the Big Creek watershed that flows through the Jefferson Proving Grounds (JPG) in southeastern Indiana. The objective of this study is to provide flood flows for given return periods and associated sediment transport and yield for environmental analyses. Data and parameters for this effort were obtained from reports, maps, and web-based routines to support modeling estimates of erosion rate.

Watershed Delineation

Digital Elevation Model (DEM) data for the Big Creek watershed were downloaded from the following web site: http://data.geocomm.com/catalog/US/61066/sublist.html. These data were provided in U.S. Geological Service (USGS) Spatial Data Transfer Standard (SDTS) format. The following sections were necessary to cover the JPG and Big Creek watershed: Volga, Clifty Falls, Vernon, San Jacinto, and Rexville. Data in the SDTS format cannot be used by the ESRI ArcGIS™ system used in this study; however, ESRI does provide a data translator that takes SDTS raster data and coverts it into grids usable by ArcGIS. After converting the data, grid cell size was checked for consistency, converting 10- by 10-meter grids to 30- by 30-meter grids as necessary. All data were in the same projection [North American Datum (NAD) 1927 Universal Transverse Mercator (UTM) zone 16N]. A single ArcGIS™ grid was generated using the mosaic function. This grid was checked for sinks or missing data with those cells being filled using values calculated from the adjacent cells. After obtaining a filled grid, a flow direction grid was determined based on elevation values and then a flow accumulation grid was calculated. Using these grids, sub-basin outlines and areas, channel lengths, and elevation changes were calculated. Outlines of the JPG and depleted uranium (DU) impact areas were used from data provided by Science Applications International Corporation (SAIC). Figure C1-1 presents the results of these processing and location of nodes used later in the flood analyses.

Flood Analyses

Flood analyses used the U.S. Army Corp of Engineers (USACE) Hydrologic Engineering Center (HEC) model, known as HEC-1, as implemented on a Microsoft Windows™-based system by Haestad Methods (HEC 1990). This code is commonly used to provide flood information. The analysis only predicts flood hydrographs at various nodes through the watershed as described in the previous section. The results presented do not include floodplain definition that would be performed using HEC-2 or HEC-River Analysis System (HEC-RAS). Floodplain mapping (see McLin et al. 2001 for an example) requires more detailed analysis of channel conditions and time than was available.

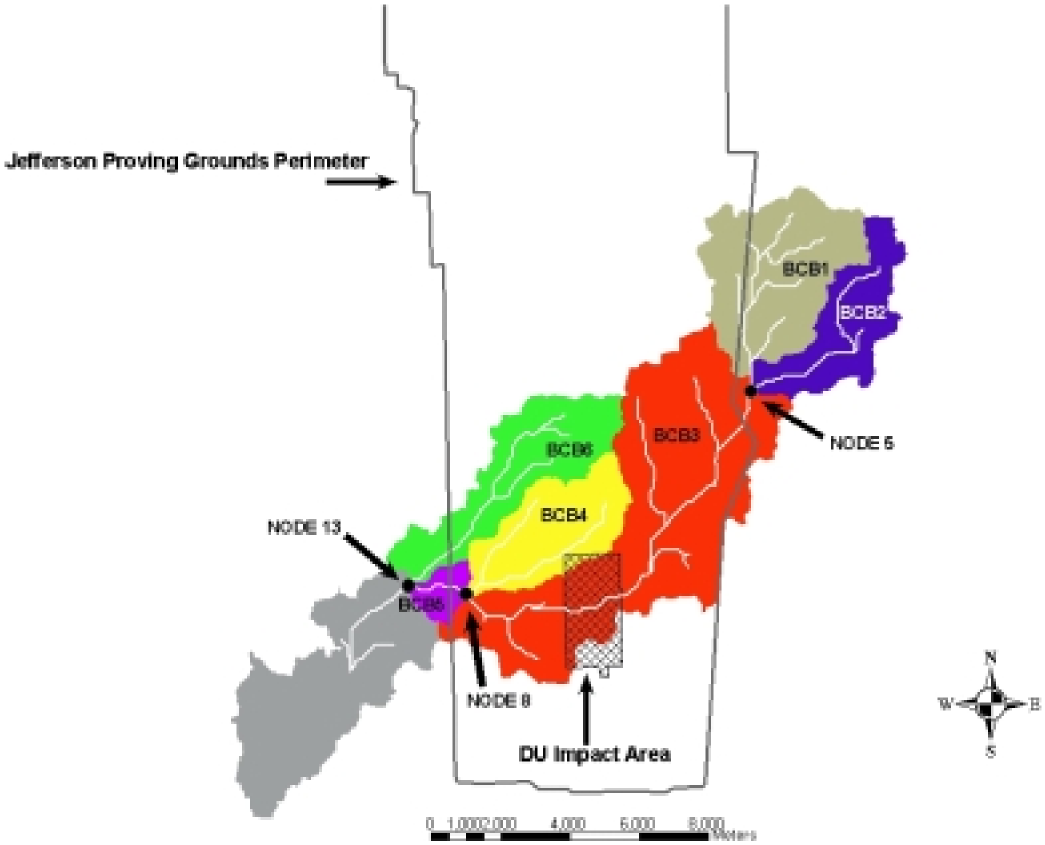


Figure C1-1. Big Creek Watershed with Identified Sub-basins and Nodes used in the HEC-1 Modeling of Flood Flows

The analysis proceeds by developing the flood estimates for the 2-, 10-, 25-, 50-, and 100-year, 24-hour duration rainfall event and using the resulting hydrologic data to estimate sediment discharge at two locations on Big Creek. The computational interval for both rainfall input and runoff was one hour. This section will present the watershed network, parameter estimates, and results used by HEC-1 for the flood analysis of Big Creek, and the next section will examine suspended sediment discharge and yield.

Watershed network – The first step is to create a network based on the watershed information presented in the previous section. The HEC-1 network representation is presented in Figure C1-2. A description of the network follows. The icons with BCB1 (Big Creek Basin 1), BCB2, BCB3, BCB4, BCB5, and BCB6 are computed runoff nodes, which represent upland areas that generate runoff from rainfall events. Icons that are designated Node 5, Node 8, and Node 13 are confluence points where two or more hydrographs are combined. Water is routed through the watershed using routing nodes (Node 6 and Node 10). The computed runoff and routing nodes have different methods for making calculations that will be described in the following section. Confluence nodes combine hydrographs and these nodes do not have any options.

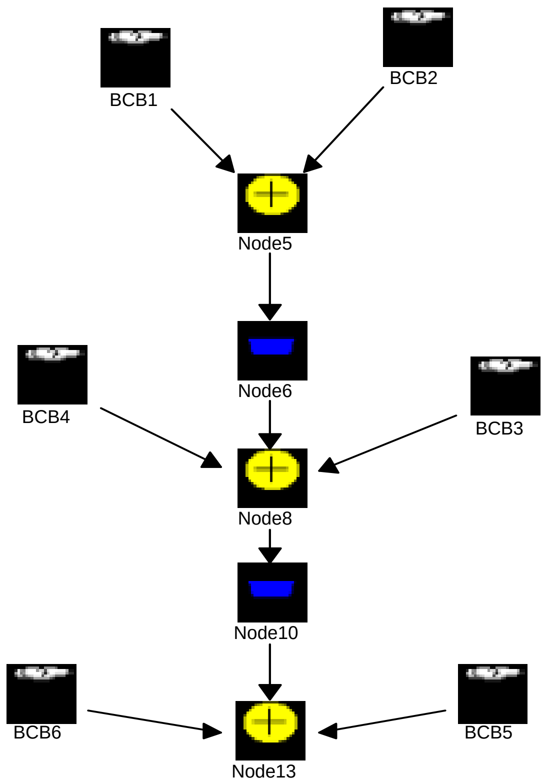


Figure C1-2. HEC-1 Network Diagram for Flood Flow Estimates for Big Creek

Using the information from the watershed delineation, the properties for each node are given in Table C1-1. The confluence nodes represent that area upstream from the locations. Node 6 and Node 10 route flow through BCB3 and BCB5, and all other basin input at their outlets. Flood and sediment discharges are given for Node 8 and Node 13. Data are available for each node if needed.

Rainfall amounts and distribution – Flood flows were estimated for 2-, 10-, 25-, 50-, and 100-year return periods and a 24-hour duration rainfall event. Rainfall amounts for these return periods were determined using a web-based procedure located at the URL http://pasture.ecn.purdue.edu/~sedspec/ for Jefferson County, Indiana. By selecting the "Database Frontend" button, rainfall amounts can be estimated for selected durations and return periods for various counties in the United States using either the U.S. Weather Bureau Report TP-40 or the Midwestern Climate Center analysis. We used the Midwestern Climate Center for our calculations. The rainfall amounts appear in Table C1-2.

Rainfall distribution assumed the Soil Conservation Service (SCS) Type II storm from Kent (1973). This rainfall distribution is suggested for areas of the United States other than the west coast and Alaska. Values of the Type II distribution by hour are given in Table C1-3.

Table C1-1. Area, Length, and Elevation Change for Sub-basins, Routing Channels, and Confluences for Big Creek used in Flood Analyses

Node	Area (km^2)	Length (m)	Elevation Change (m)
BCB1	16.87	5006.3	38.0
BCB2	9.69	6813.1	41.0
Node 5	26.56	NA	NA
Node 6	NA	13154.40	51.0
BCB3	37.65	13154.40	51.0
BCB4	10.86	5450.24	40.0
Node 8	75.07	NA	NA
Node 10	NA	1884.36	27
BCB5	2.03	1884.36	27
BCB6	13.02	7421.44	41
Node 13	90.12	NA	NA

km^2 = square kilometers.
m = meter.
NA = Not applicable.

Table C1-2. Rainfall Amounts for 24-hour Duration Event for Selected Return Periods from Midwestern Climate Center Data Located at http://pasture.ecn.purdue.edu/~sedspec/

Return Period (Years)	Rainfall Amount (mm)
2	76.96
10	112.27
25	136.91
50	157.48
100	180.85

mm = millimeters.

Runoff parameters – The SCS Curve Number (CN) method was selected to partition rainfall into runoff for each of the compute runoff nodes (the BCB#). Estimates for CNs depend on selecting the hydrologic soil group and land cover condition. The hydrologic soil groups were selected based on information in Table C1-19 of Nickell (1985). The soils were all essentially hydrologic soil group D, which means they have high potential runoff. The surface condition qualifier varied between on- and off-site of the JPG. Land use off-site was assumed to be more agriculture so a "fair" condition was assigned and for the JPG, the condition was "good" because basically the land was allowed to recover from any previous anthropogenic disturbance, except for certain locations such as the DU Impact Area. Sub-basins BCB1 and BCB2 were assumed to be impacted by agriculture more than the rest of the watershed with row crops as the land cover for those basins. Approximately 25% of BCB1 was located in the JPG so BCB1 had a weighted CN based on wood-grassland (25%) and row crop agriculture (75%). The CNs were estimated using the same web site as the rainfall, http://pasture.ecn.purdue.edu/~sedspec/, and selecting the TR-55 button. The menu will lead one through the selection process, and the CN value will be generated. For all calculations, the initial abstraction (Ia) for the SCS CN method was set to 0.2, and no impervious area was assumed. The CNs for each sub-basin are given in Table C1-4.

Table C1-3. SCS Type II Rainfall Distribution for 24-hour Duration Event

Time (hours)	Cumulative Rainfall
0	0.0
1	0.011
2	0.022
3	0.035
4	0.048
5	0.064
6	0.080
7	0.100
8	0.120
9	0.147
10	0.181
11	0.235
12	0.663
13	0.772
14	0.820
15	0.850
16	0.880
17	0.898
18	0.916
19	0.930
20	0.952
21	0.964
22	0.976
23	0.988
24	1.0

Source: Kent 1973.
SCS = Soil Conservation Service.

Table C1-4. Runoff Curve Numbers and Lag Times Used in Flood Estimation for Big Creek for Each Sub-basin

Sub-basin	CN	Lag Time (hours)
BCB1	84	0.90
BCB2	85	1.25
BCB3	79	2.45
BCB4	79	0.97
BCB5	82	0.33
BCB6	79	1.38

CN = curve number.

Runoff for the computed runoff nodes was routed to the basin outlet using the SCS unit hydrograph method. This requires an estimate of the lag time (t_l) for each basin. The lag time can be related to the time of concentration (t_c) by the following formula (Kent 1973)

$$t_l = 0.6 * t_c \ , \quad (1)$$

where t_l is lag time (hours) and t_c is time of concentration in hours. The t_c was estimated using the Kirpich formula (Maidment 1993):

$$t_c = 0.0078 * L^{0.77} * S^{-0.385} \ , \tag{2}$$

where t_c is time of concentration in minutes, L is the length of watershed from divide to outlet (ft), and S is the channel slope (ft/ft). Values for L and S were obtained from Table C1-1 and converted to English units for use in Equation 2. The lag time for each sub-basin is given in Table C1-4.

Stream routing – The Muskingham method was used for routing water in Node 6 and Node 10. Data on inflow and outflow hydrographs that can be used to support parameter estimation for the Muskingham method were not readily available. There are two parameters that require estimation for the Muskingham method, which provides the relative contribution of the inflow hydrograph (X) and K, which is the travel time through the reach. Values for X are $0 \leq \times \leq 0.5$, and a value of 0.2 was used. The parameter K was estimated assuming a flow velocity of 1.52 m/s and dividing this velocity into the channel length in Table C1-1. The values for K are 2.4 for Node 6 and 0.3 for Node 10. The number of reaches for both Node 6 and Node 10 were set to 1.

Results of flood calculations - Data are presented for two nodes that can be seen in Figures 1 and 2. Node 8 is near the outlet of JPG so that estimates of flood flows and sediment discharge at that location can be identified, and Node 13 provides the flood flow and sediment transport from the entire JPG. The lack of data from Big Creek meant that data from other nearby locations are needed to test consistency of the model results. Two major drainages are Brush Creek near Nebraska, Indiana (USGS Station ID 03368000; see URL http://waterdata.usgs.gov/nwis/peak/?site_no=03368000) and Indian-Kentuck Creek near Canaan, Indiana (USGS Station ID 03291780; see URL http://waterdata.usgs.gov/nwis/peak/?site_no=03291780). Brush Creek has a drainage area of 29.53 km^2 (11.4 mi^2) and a record length of 46 years. It is located north of JPG. Indian-Kentuck Creek has a drainage area of 71.22 km^2 (27.5 mi^2) and a record length of 32 years. Indian-Kentuck Creek is located east of the JPG. Annual peak flow data from these steams allow comparison with the model-generated values for Big Creek to establish that the simulated values are reasonable.

The peak flow values estimated using the parameters values in HEC-1 for Node 8 and Node 13 are presented in Table C1-5. The frequency distribution is an approach to compare flood between watersheds. The return periods in Table C1-5 provide the frequencies for Big Creek. Using the annual peak flows obtained for Brush Creek and Indian-Kentuck Creek and the Weibull plotting position formula (Maidment 1993) a comparison of the flood frequencies are given in Figure C1-3. A logarithmic scale is used for the y-axis because floods have been shown to have a skewed distribution. The HEC predicted peak flows are greater than those observed from either Brush or Indian-Kentuck Creeks. This is somewhat expected because the record of observed flows is short and the difference in area between Big Creek and the other two watersheds. Figure C1-4 shows the probability plot with the flood peak flows on a unit area basis (km^2) to account for the difference in area between the various watersheds. In Figure C1-4, the predicted Big Creek peaks are less than those from Brush Creek and Indian-Kentuck. This is expected because the Big Creek watershed through the Jefferson Proving Grounds is in forested conditions leading to less runoff generation than the other two watersheds where more agriculture is practiced. The peak flow values in Figure C1-4 for Big Creek HEC simulations are also given in Table C1-5.

Table C1-5. Peak Flow Values for Given Return Periods for Big Creek at Selected Locations

Return Period	Node 8 (m^3/s)	Node 13 (m^3/s)	Node 8 ($m^3/s\text{-}km^2$)	Node 13 ($m^3/s\text{-}km^2$)
2	80.59	107.04	1.07	1.19
10	148.09	193.40	1.94	2.14
25	195.19	258.08	2.60	2.86
50	237.49	313.72	3.16	3.48
100	286.48	378.14	3.81	4.19

km^2 = square kilometers.
m^3/s = cubic meters per second.

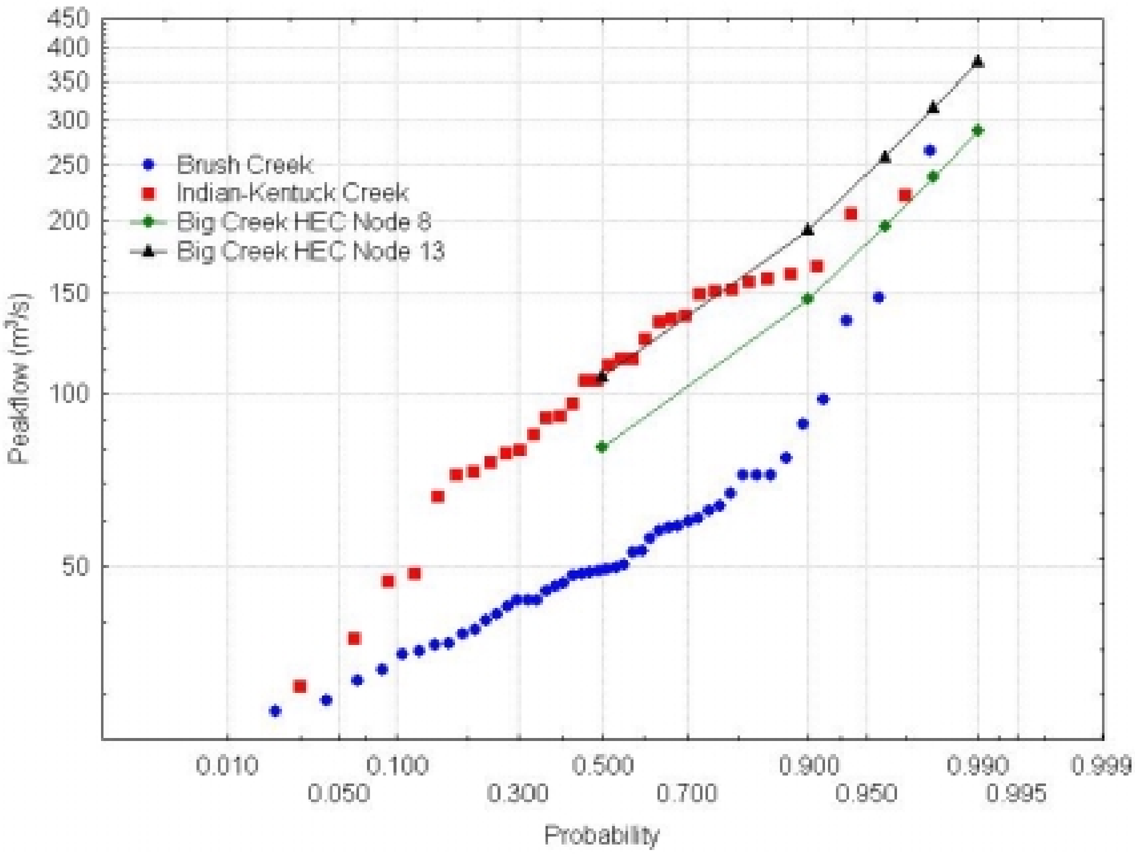


Figure C1-3. Frequency Plot of Peak Flows For Observed Data from Brush and Indian-Kentuck Creeks and HEC Predicted Peak Flows for Big Creek from Node 8 and Node 13

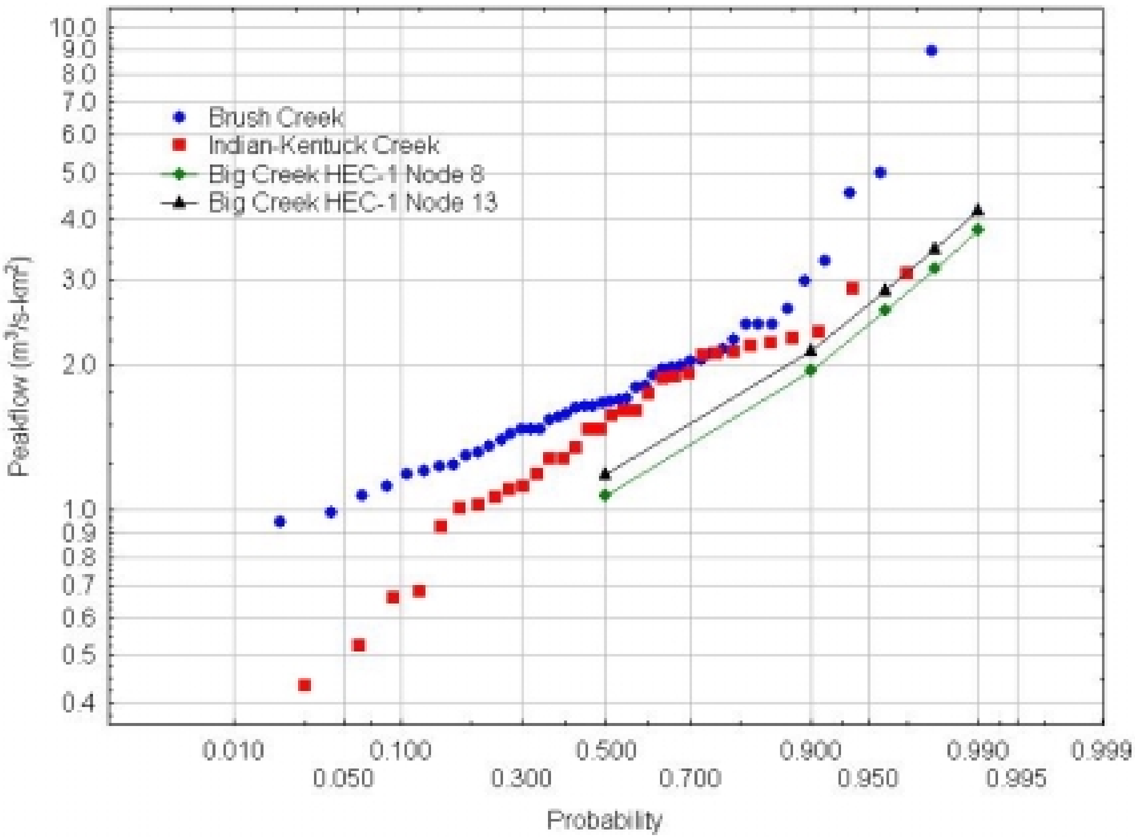


Figure C1-4. Frequency Plot of Peak Flows on a Unit Area Basis for Observed Data from Brush Creek and Indian-Kentuck Creeks and HEC Predicted Peak Flows on a Unit Area Basis for Big Creek from Node 8 and Node 13

Overall, the simulation by HEC on Big Creek appears to be reasonable for the area given the data from Brush and Indian-Kentuck Creeks. From Figure C1-4, it can be seen how the smaller watersheds have a larger peak flow per unit area, which is an observed trend with other data. One inconsistency is the higher peak flow per unit area (Figure C1-4) for Node 13 over Node 8. This is most likely due to the Muskingham routing between these two nodes. The computational time interval was set at 1 hour, and the travel time through the reach was estimated to be 0.3 hour. So basically the hydrograph from Node 8 is routed to Node 13 in the same time interval. In reviewing the hydrographs the peak flow occurs at the same time for both Nodes 8 and 13, which will not happen in the watershed. To support a more detailed simulation, data on channel characteristics must be available to make a better estimate of routing parameters.

Suspended Sediment Transport and Yield

Water discharge vs. sediment concentration and discharge – Statistical analyses were performed for average discharge rates (m^3/s) vs. sediment concentration (mg/L) and sediment discharge (t/d) using 20 samples from 1977–1980 at Indian-Kentuck Creek near Cannan, Indiana, using 43 samples from 1964–1968 at Brush Creek near Nebraska, Indiana, and using 25 samples from 1969–1983 at South Hogan Creek near Dillsboro, Indiana. These USGS data were obtained from the web site, http://waterdata.usgs.gov/nwis/qwdata, and are summarized in Table C1-6.

Table C1-6. Summary of Water and Sediment Data for Indian-Kentuck Creek, Brush Creek, and South Hogan Creek USGS Gauging Sites near JPG

Site	Mean Discharge (m^3/s) Range in ( )	Std Dev of Discharge (m^3/s)	Mean Suspended Sediment Concentration (mg/L) Range in ( )	Std Dev of Suspended Sediment Concentration (mg/L)	Mean Sediment Discharge (t/d) Range in ( )	Std Dev Sediment Discharge (t/d)
03291780 Indian-Kentuck Creek near Cannan, Indiana A = 27.5 sq mi N = 20	1.68 (19.6)	4.45	49.1 (224)	68.6	22.9 (398)	88.6
03368000 Brush Creek near Nebraska, Indiana A = 11.4 sq mi N = 43	0.997 (18.7)	3.26	112. (2690)	426.	122. (4345)	671.
03276700 South Hogan Creek near Dillsboro, Indiana A = 38.1 sq mi N = 25	2.29 (23.5)	5.23	66.4 (323)	85.3	47.3 (669)	143.

Note: The 8-digit codes shown for each site are the USGS site numbers.
JPG = Jefferson Proving Ground.
USGS = U.S. Geological Service.

Linear and log-transform regressions were run on these data. The results (i.e. the best water discharge predictor equation for suspended sediment concentration or sediment discharge) showed that the log-transform was inappropriate and the results were inconclusive.

Therefore, linear regression results for data from the sites listed in Table C1-6 are summarized in Table C1-7. The suspended sediment concentration, C, is in mg/L, sediment discharge, Qs, is in t/d, and water discharge, Q, is in m^3/s. Notice that Indian-Kentuck and South Hogan Creek have similar results (i.e. the sign of the intercepts are the same and the values of the coefficients are similar) in Table C1-7. However, the regression intercepts for Brush Creek are quite different (for suspended sediment concentration, the intercept for Brush Creek is negative while the intercepts are positive for the other two locations) and the regression coefficients (the b or slope values) are about an order of magnitude larger for the Brush Creek data.

The differences in the regression results in Table C1-7 can be partially explained by the ranges of the data shown in parentheses in Table C1-6. The ranges of the water discharge values in Table C1-6 are comparable, but the range of suspended sediment concentrations and sediment discharge is about an order of magnitude larger for the Brush Creek data. Given similar water discharge and higher suspended sediment concentration, then the suspended sediment discharge, as their product, must also be larger.

Prediction equations of the form $C = a + bQ$ with $a < 0$, can produce spurious results (i.e. negative suspended sediment concentrations) as the discharge, Q, approaches zero. Therefore, we performed regression analyses with the intercept set at zero (called regression through the origin) for each of the data sets and the results are summarized in Table C1-8. The results are prediction equations of the form $C = bQ$

and Qs = bQ. Again, notice that the b values for the data from Brush Creek are about an order of magnitude larger than at the other two sites. Also, notice that except for C vs. Q at Indian-Kentuck Creek, there was little reduction in R^2 values when going from regression with an intercept to regression through the origin.

Table C1-7. Summary of Linear Regression Results for the Gauging Stations Listed in Table C1-6

Site	Linear Regression C = a + bQ			Linear Regression Qs = a + bQ		
	Intercept a	**Coefficient b**	**R^2**	**Intercept a**	**Coefficient b**	**R^2**
03291780 Indian-Kentuck Creek near Cannan, Indiana N = 20	32.8	9.71	0.40	-9.25	19.2	0.93
03368000 Brush Creek near Nebraska, Indiana N = 43	–13.6	126.	0.93	-66.8	190.	0.85
03276700 South Hogan Creek near Dillsboro, Indiana N = 25	32.0	15.0	0.84	–15.1	27.1	0.98

Table C1-8. Summary of Linear Regression Through the Origin Results for the Gauging Stations Listed in Table C1-6

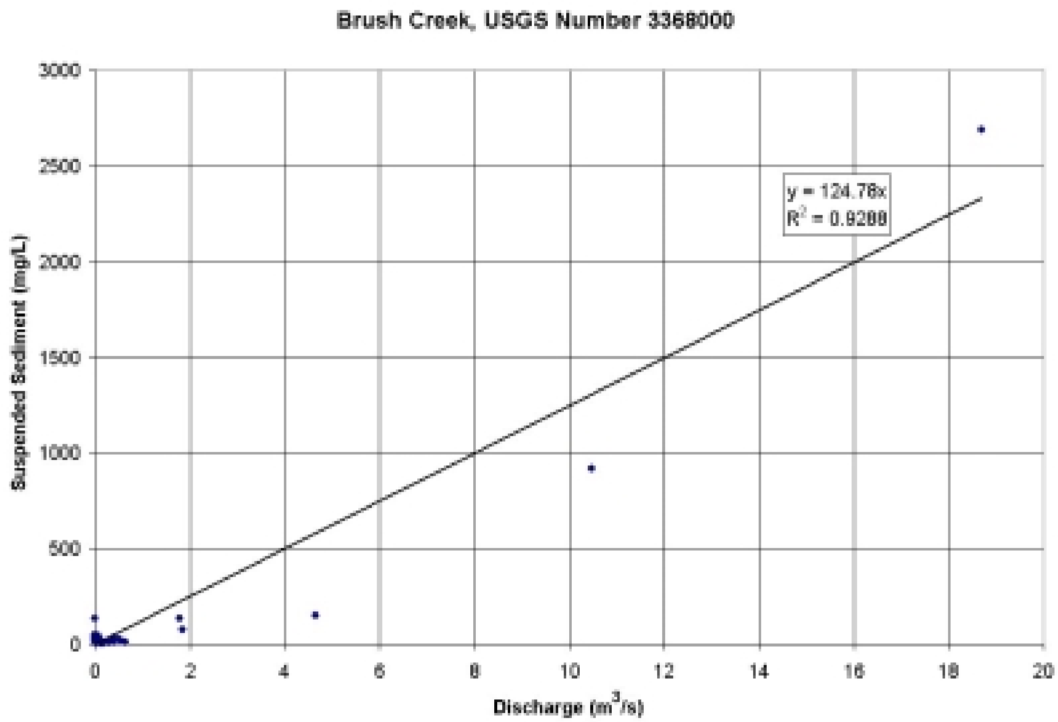
Site	Regression Through the Origin C = bQ		Regression Through the Origin Qs = bQ	
	Coefficient b	**R^2**	**Coefficient b**	**R^2**
03291780 Indian-Kentuck Creek near Cannan, Indiana N = 20	12.3	0.19	18.5	0.92
03368000 Brush Creek near Nebraska, Indiana N = 43	125.	0.93	184.	0.85
03276700 South Hogan Creek near Dillsboro, Indiana N = 25	17.3	0.72	26.0	0.97

<u>Procedure for estimating sediment yields for flood events on Big Creek</u> – The longer period of record at Brush Creek and the greater range in observed suspended sediment concentration there suggest that we should use it to estimate the water discharge – suspended sediment concentration relationship for Big Creek. This estimating equation is:

$$C\ (\text{mg/L}) = 125 \times Q\ (\text{m}^3/\text{s})\ , \tag{3}$$

where Q is the HEC-1 computed water discharge rate at any given time A discharge rate of 28.32 m^3/s would produce an estimated suspended sediment concentration of 3,540 mg/L, which is 0.354% by weight, and a peak discharge of 142 m^3/s would produce a suspended sediment concentration of 17,750 mg/L, which is equal to 1.775% by weight.

The regression through the origin relationship for the Brush Creek data is shown in Figure C1-5. Notice that the maximum observed discharge rate is 18.7 m^3/s, which produced a suspended sediment concentration of 2,690 mg/L = 0.269% by weight. The premise of Equation 3 as an estimating equation for Big Creek is that the water discharge – suspended sediment concentration relationship can be transposed from Brush Creek to Big Creek and will produce reasonable estimates of suspended sediment concentration. As shown in Table C1-8, the coefficient in the equation relating water discharge to sediment discharge can vary by about a factor of 10 for streams in the JPG area. The error in transposing Equation 3 from Brush Creek to Big Creek depends upon a number of factors including: (1) length of record, (2) number of larger storms sampled, (3) the degree of hydrologic similarity between Big Creek and surrounding streams, and (4) the stationarity in time and uniformity in space of



the data used to determine Equation 3.

Figure C1-5. Regression Through the Origin for the USGS Measured Data at Brush Creek near Nebraska, Indiana

(These data were obtained from the U.S. Geological Survey web site: http://waterdata.usgs.gov/nwis/qwdata.)

Estimating sediment yields for simulated flood events on Big Creek – Flood hydrographs (water discharge as a function of time, starting at zero flow, rising to the peak flow, and then receding back to zero flow or zero flow above base flow) simulated by the HEC-1 were used to calculate suspended sediment concentration (using Equation 3). Suspended sediment discharge was calculated as the product of water discharge and suspended sediment concentration throughout the duration of the flood. Water and suspended sediment yield were then calculated by numerically integrating the rates of water and suspended sediment discharge throughout the flood hydrographs. These calculations produced estimates of peak discharge, water yield, and suspended sediment yield for each flood event. These estimated data for Big Creek at two locations are summarized in Table C1-9 in customary English units (cubic feet per second, cfs, acre feet, AF, and English short tons, t). The data in Table C1-10 are in customary metric units (cubic meters per second, m^3/s, megaliters, ML, and metric tons, t).

Table C1-9. Results for Suspended Sediment Yield Estimates at Nodes 8 and 13, HEC-1 Analyses for Big Creek, at the JPG

Return Period (y)	Node 8			Node 13		
	Peak (cfs)	Volume (AF)	Sediment Yield (t)	Peak (cfs)	Volume (AF)	Sediment Yield (t)
2	2846.	2393.	21,593.	3780.	2850.	31,780.
10	5159.	4189.	66,973.	6830.	4999.	99,168.
25	6893.	5519.	116,643.	9114.	6592.	173,203.
50	8387.	6660.	170,045.	11,079.	7957.	252,955.
100	10,117.	7978.	244,134.	13,354.	9538.	363,808.

Note: Results are in English units.
HEC = Hydrologic Engineering Center.
JPG = Jefferson Proving Ground.

Table C1-10. Results for Suspended Sediment Yield Estimates at Nodes 8 and 13, HEC-1 Analyses for Big Creek, at the JPG

Return Period (y)	Node 8			Node 13		
	Peak (m^3/s)	Volume mL	Sediment Yield (t)	Peak (m^3/s)	Volume (ML)	Sediment Yield (t)
2	80.6	2952.	19,589.	107.	3515.	28,830.
10	146.	5167.	60,757.	193.	6166.	89.963.
25	195.	6808.	105,816.	258.	8131.	157,126.
50	238.	8215.	154,261.	314.	9815.	229,476.
100	287.	9841.	221,473.	378.	11,765.	330,039.

Note: Results are in English units.
HEC = Hydrologic Engineering Center.
JPG = Jefferson Proving Ground.

Often, it is easier to compare results when they are normalized per unit area. Normalized English units of inches, in., inches per hour, in./hr, and tons per acre, t/a, are used in Table C1-11. Normalized metric units of millimeters, mm, millimeters per hour, mm/h, and metric tons per hectare, t/ha, are used in Table C1-12.

Table C1-11. Results for Runoff and Suspended Sediment per Unit Area at Nodes 8 and 13

Return Period (y)	Node 8			Node 13		
	Peak (in./hr)	Volume (in.)	Sediment Yield (t/a)	Peak (in./hr)	Volume (in.)	Sediment Yield (t/a)
2	0.152	1.55	1.16	0.168	1.54	1.43
10	0.276	2.71	3.61	0.304	2.69	4.45
25	0.369	3.57	6.29	0.406	3.55	7.79
50	0.448	4.31	9.17	0.493	4.29	11.36
100	0.541	5.16	13.16	0.595	5.14	16.34

Note: Results are in English units.

Notice that runoff peak rates and suspended sediment yields increase at a greater rate with increasing return periods than does runoff volume. This is the usual case in simulated and observed data per unit area. Also, notice that all of the data presented herein (Tables 9 to 11) are simulated. Therefore, it is necessary to examine them in the context of measured data. We used long-term, annual sediment yield data from reservoir sedimentation studies (e.g. Chow, 1964, Chapter 17, Table C1-17-I-7, pp. 17-28 to 17-29). Finally, notice that the simulated data are for flood events with return periods from 2 to 100 years, whereas the reservoir sedimentation data are long-term average annual values. Direct comparisons cannot be made between individual simulated flood events and measured average annual data. However, the average annual sediment yields should be roughly comparable in magnitude to the values of the 2- and 10-year suspended sediment yields.

Table C1-12. Results for Runoff and Suspended Sediment per unit area at Nodes 8 and 13

Return Period (y)	Node 8			Node 13		
	Peak (mm/h)	Volume (mm)	Sediment Yield (t/ha)	Peak (mm/h)	Volume (mm)	Sediment Yield (t/ha)
2	3.86	39.4	2.60	4.27	39.1	3.21
10	7.01	68.8	8.09	7.72	68.3	9.98
25	9.37	90.7	14.10	10.31	90.2	17.47
50	11.4	109.5	20.56	12.55	109.0	25.47
100	13.7	131.1	29.50	15.11	130.6	36.63

Note: Results are in metric units.

Chow (1964) presented annual sediment yield (from reservoir sedimentation rates) from seven small watersheds in the Midwest ranging in size from 2.59 km^2 to 156 km^2. These results for average annual sediment yield in t/ha are summarized in Table C1-13.

Table C1-13. Summary of Average Annual Sediment Yields from Seven Small Watersheds in the Midwest

Name/Location	Drainage Area (km^2)	Record Length (y)	Annual Sediment Yield (t/ha)
Caldwell, Waverly, Ohio	2.59	12	1.16
Decker, Piqua, Ohio	5.96	10	3.61
Shepard Mountain, Ironton, Missouri	10.1	10	1.65
Westville, Alliance, Ohio	21.3	37	1.01
Upper Pine, Eldora, Iowa	35.7	13.3	5.22
Carlinville, Carlinville, Illinois	66.8	10.4	3.57
Bloomington, Bloomington, Illinois	156.	22.7	1.80

Source: Adapted from Chow (1964).

The average annual sediment yield for these seven reservoirs ranged from about 1 to 5 t/ha. The 2-year floods (Table C1-S 7) had suspended sediment yields of 2.60 and 3.21 t/ha, respectively, for Nodes 8 and 13. The corresponding flood yields for the 10-year flood were 8.09 and 9.98 t/ha. Therefore, the average annual sediment yields from the reservoir surveys ranged from less than the simulated 2-year suspended sediment yields to about midway between the simulated 2-year and 10-year suspended sediment yields. Again, while average annual sediment yield cannot be directly compared with simulated suspended sediment yields from the 2- and 10-year floods, their values are comparable in magnitude. This provides empirical support for the general order of magnitude of the simulated suspended sediment yields from this study.

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ATTACHMENT 2 – DATA CATALOG

The following tables are a data catalog of the input parameters, default values, and justifications for selection of various values used in the Residual Radioactivity (RESRAD) analyses. The distributions of values selected for uncertainty analyses are also listed. Jefferson Proving Ground (JPG) values that are identical with values in the default values column were used without additional references; other selected values were referenced.

Table C2-1. Values for Parameters Common to all Exposure Scenarios

Parameter	Default Value	JPG Value	Probabilistic Values (Distribution)	Reference
Radionuclide Concentrations and Transport Parameters				
Depleted Uranium[a] (pCi g^{-1})	0	94 or 225		Problem Definition
Basic Radiation Dose Limit (mrem y^{-1})	25	25 or 100		Regulatory Limits
Uranium Distribution Coefficient[b]	50	50	50 (min. 5, max 60, Triangular)	Yu et al. (2001); Sheppard and Thibault (1992)
Contaminated Zone Parameters				
Contaminated Zone Area (m^2)	10,000	5×10^5 or 1.2×10^6		SEG 1996a
Contaminated Zone Thickness (m)	2	0.15		SEG 1996a; Ebinger et al. 1995
Length Parallel to Aquifer Flow (m)	100	100		
Depth of Cover (m)	0	0		
Bulk Density of Contaminated Zone (g cm^{-3})	1.5	1.4		Saxton et al. 1986; Meyer and Gee (1999)
Contaminated Zone Erosion Rate (m y^{-1})	0.001	.001		
Contaminated Zone Total Porosity	0.4	0.45		Saxton et al. 1986; Meyer and Gee (1999)
Contaminated Zone Field Capacity	0.2	0.3		Saxton et al. 1986; Meyer and Gee (1999)
Contaminated Zone Hydraulic Conductivity (m y^{-1})	10	30		Meyer and Gee (1999)
Contaminated Zone b Parameter	5.3	5.3		
Evapotranspiration Coefficient	0.5	0.5		
Wind Speed (m s^{-1})	2	2		
Precipitation (m y^{-1})	1	1		
Irrigation (m y^{-1})	0.1	0.1 or 0		
Irrigation Mode	Overhead	Overhead		
Runoff Coefficient	0.2	0.2		
Watershed Area for Nearby Pond or Stream (m^2)	1×10^6	1×10^6		
Accuracy for Computations	0.001	.001		
Saturated Zone Parameters				
Bulk Density of Saturated Zone (g cm^{-3})	1.5	1.5		
Saturated Zone Total Porosity	0.4	.4		
Saturated Zone Field Capacity	0.2	.2		
Saturated Zone Hydraulic Conductivity (m y^{-1})	100	100		
Saturated Zone Hydraulic Gradient	0.2	.2		

Table C2-1. Values for Parameters Common to all Exposure Scenarios (Continued)

Parameter	Default Value	JPG Value	Probabilistic Values (Distribution)	Reference
Saturated Zone b Parameter	5.3	5.3		
Water Table Drop Rate (m y^{-1})	0.001	.001		
Well Pump Intake Depth (m) below water table	10	10		
Model for Water Transport	Non-dispersive	Non-dispersive		
Well Pumping Rate (m^3 y^{-1})	250	250		
Unsaturated Zone Parameters[c]				
Number of Zones	1	5^3		
Thickness (for each zone) [m]	4	0.3		Nickell 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.35		Saxton et al. 1986; Meyer and Gee (1999)
Unsaturated Zone Total Porosity	0.4	.45		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	.3		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	30		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		
Zone 2				
Thickness (for each zone) [m]	4	0.38		Nickell 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.4		Saxton et al. 1986; Meyer and Gee (1999)
Unsaturated Zone Total Porosity	0.4	0.45		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	0.2		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	0.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	30		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		
Zone 3				
Thickness (for each zone) [m]	4	0.59		Nickell 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.35		Saxton et al. 1986; Meyer and Gee (1999)
Unsaturated Zone Total Porosity	0.4	0.4		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	0.2		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	0.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	10		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		
Zone 4				
Thickness (for each zone) [m]	4	0.68		Nickell 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.35		Saxton et al. 1986; Meyer and Gee (1999)

Table C2-1. Values for Parameters Common to all Exposure Scenarios (Continued)

Parameter	Default Value	JPG Value	Probabilistic Values (Distribution)	Reference
Unsaturated Zone Total Porosity	0.4	0.4		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	0.2		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	0.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity ($m\ y^{-1}$)	10	10		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		
		Zone 5		
Thickness (for each zone) [m]	4	1.5		Nickell, 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone ($g\ cm^{-3}$)	1.5	1.3		Saxton et al. 1986; Meyer and Gee (1999)
Unsaturated Zone Total Porosity	0.4	0.45		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	0.2		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	0.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity ($m\ y^{-1}$)	10	30		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		

[a]Nominal isotopic composition of depleted uranium is from Shleien (1992).
[b]A separate distribution coefficient is required for the contaminated zone, each unsaturated zone, and the saturated zone.
[c]Properties for each horizon entered from top (zone 1) to bottom (zone 5) of the soil profile. Total thickness of unsaturated zone is 3.6 m.

Table C2-2. Parameter Values for On-Site Worker (Table 6, Scenario 1)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
		Occupancy, Inhalation, and Gamma Parameters		
Inhalation Rate ($m^3\ y^{-1}$)	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation ($g\ m^{-3}$)	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.2		Scenario definition
Outdoor Time Fraction	0.25	0.05		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
		Ingestion Pathways, Dietary Data		
Fruit, Vegetable, and Grain Consumption ($kg\ y^{-1}$)	160	NA		
Leafy Vegetable Consumption ($kg\ y^{-1}$)	14	NA		
Milk Consumption ($L\ y^{-1}$)	92	NA		
Meat and Poultry Consumption ($kg\ y^{-1}$)	63	NA		
Fish Consumption ($kg\ y^{-1}$)	5.4	NA		

Table C2-2. Parameter Values for On-Site Worker (Table 6, Scenario 1) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Seafood Consumption (kg y^{-1})	0.9	NA		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	NA		
Contaminated Fraction				
Drinking Water	1	NA		
Livestock Water	1	NA		
Irrigation Water	1	NA		
Aquatic Food	0.5	NA		
Plant Food	–1	NA		
Meat	–1	NA		
Milk	–1	NA		
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	NA		
Livestock Fodder Intake for Milk (kg d^{-1})	55	NA		
Livestock Water Intake for Meat (L d^{-1})	50	NA		
Livestock Water Intake for Milk (L d^{-1})	160	NA		
Livestock Soil Ingestion (kg d^{-1})	0.5	NA		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	NA		
Depth of Soil Mixing Layer (m)	0.15	NA		
Root Depth (m)	0.9	NA		
Groundwater Use Fractions				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-3. Parameter Values for Off-Site Hunter (Table 6, Scenario 2) and On-Site Hunter (Table 7, Scenario 3). On-site Hunter includes an inhalation pathway and external exposure pathway, whereas Off-Site Hunter does not.

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	12,264		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0		Scenario definition
Outdoor Time Fraction	0.25	0.05		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	NA		
Leafy Vegetable Consumption (kg y^{-1})	14	NA		
Milk Consumption (L y^{-1})	92	NA		
Meat and Poultry Consumption (kg y^{-1})	63	52	52 ± 7 (normal)	Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	NA		
Seafood Consumption (kg y^{-1})	0.9	NA		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	NA		
Contaminated Fraction				
Drinking Water	1	NA		
Livestock Water	1	1		
Irrigation Water	1	NA		
Aquatic Food	0.5	NA		
Plant Food	–1	NA		
Meat	–1	NA		
Milk	–1	NA		
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	68		
Livestock Fodder Intake for Milk (kg d^{-1})	55	NA		
Livestock Water Intake for Meat (L d^{-1})	50	50		
Livestock Water Intake for Milk (L d^{-1})	160	NA		
Livestock Soil Ingestion (kg d^{-1})	0.5	NA		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	NA		
Depth of Soil Mixing Layer (m)	0.15	NA		
Root Depth (m)	0.9	NA		

Table C2-3. [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Groundwater Use Fractions				
Drinking Water	1	NA		
Livestock Water	1	1		
Irrigation Water	1	NA		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-4. Values for Scenario 3, Table 6 and Scenario 11, Table 6.

Parameter	Value	Reference
BCF, concentration factor to fish from water	10 L kg^{-1}	Yu et al., 2001
DCF, dose conversion factor	2.69 x 10-4 mrem pCi^{-1}	Yu et al., 2001
Kd	50	Yu et al., 2001
Sed (Sediment yield)	28,830 metric Ton	Attachment 1, Table 10
Big Creek Watershed Area	90 km^2	Attachment 1; Fig.1, Table 1
Big Creek Flow Volume at Node 13 (2-year return)	3.5 x 10^9 L y^{-1}	Attachment 1, Table 10
Volume Flow, East Fork of White River	3.74 x 10^9 m^3 y^{-1}	http://waterdata.usgs.gov/nwis/qwdata

Table C2-5. Parameter Values for Off-Site Farmer (Table 6, Scenario 4)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.5		Scenario definition
Outdoor Time Fraction	0.25	0.25		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	118	118 ± 7.7 (normal)	Beyeler et al. 1998
Meat and Poultry Consumption (kg y^{-1})	63	52	52 ± 7 (normal)	Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	.9		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	440 to 660	(Uniform)	Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Aquatic Food	1	0.5		
Plant Food	–1	1		Scenario Definition
Meat	–1	1		Scenario Definition
Milk	–1	1		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	68		
Livestock Fodder Intake for Milk (kg d^{-1})	55	55		
Livestock Water Intake for Meat (L d^{-1})	50	50		
Livestock Water Intake for Milk (L d^{-1})	160	160		
Livestock Soil Ingestion (kg d^{-1})	0.5	0.5		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		

Table C2-5. Parameter Values for Off-Site Farmer (Table 6, Scenario 4) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-6. Parameter Values for Industrial Worker (Table 6, Scenario 9)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.1		Scenario definition
Outdoor Time Fraction	0.25	0.1		Scenario definition
Shape of Contaminated Zone	Circular	Circular		

Table C2-6. Parameter Values for Industrial Worker (Table 6, Scenario 9) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	NA		
Leafy Vegetable Consumption (kg y^{-1})	14	NA		
Milk Consumption (L y^{-1})	92	NA		
Meat and Poultry Consumption (kg y^{-1})	63	NA		
Fish Consumption (kg y^{-1})	5.4	NA		

Table C2-6. Parameter Values for Industrial Worker (Table 6, Scenario 9) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Seafood Consumption (kg y^{-1})	0.9	NA		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	NA		
Contaminated Fraction				
Drinking Water	1	NA		
Livestock Water	1	NA		
Irrigation Water	1	NA		
Aquatic Food	0.5	NA		
Plant Food	–1	NA		
Meat	–1	NA		
Milk	–1	NA		
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	NA		
Livestock Fodder Intake for Milk (kg d^{-1})	55	NA		
Livestock Water Intake for Meat (L d^{-1})	50	NA		
Livestock Water Intake for Milk (L d^{-1})	160	NA		
Livestock Soil Ingestion (kg d^{-1})	0.5	NA		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	NA		
Depth of Soil Mixing Layer (m)	0.15	NA		
Root Depth (m)	0.9	NA		
Groundwater Use Fractions				
Drinking Water	1	NA		
Livestock Water	1	NA		
Irrigation Water	1	NA		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-7. Parameter Values for Resident Farmer (Without Irrigation) After Loss of Institutional Controls (Table 7, Scenario 1)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.5		Scenario definition
Outdoor Time Fraction	0.25	0.25		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	118	118 ± 7.7 (normal)	Beyeler et al. 1998
Meat and Poultry Consumption (kg y^{-1})	63	52	52 ± 7 (normal)	Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	.9		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	440 to 660	(Uniform)	Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	1		
Livestock Water	1	1		

Table C2-7. Parameter Values for Resident Farmer (Without Irrigation) After Loss of Institutional Controls (Table 7, Scenario 1) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Irrigation Water	1	0		
Aquatic Food	1	1		
Plant Food	–1	1		Scenario Definition
Meat	–1	1		Scenario Definition
Milk	–1	1		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	68		
Livestock Fodder Intake for Milk (kg d^{-1})	55	55		
Livestock Water Intake for Meat (L d^{-1})	50	50		
Livestock Water Intake for Milk (L d^{-1})	160	160		
Livestock Soil Ingestion (kg d^{-1})	0.5	0.5		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-8. Parameter Values for Resident Farmer (With Irrigation) After Loss of Institutional Controls (Table 7, Scenario 2)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		

Table C2-8. Parameter Values for Resident Farmer (With Irrigation) After Loss of Institutional Controls (Table 7, Scenario 2) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.5		Scenario definition
Outdoor Time Fraction	0.25	0.25		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	118	118 ± 7.7 (normal)	Beyeler et al. 1998
Meat and Poultry Consumption (kg y^{-1})	63	52	52 ± 7 (normal)	Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	.9		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	440 to 660	(Uniform)	Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Aquatic Food	1	1		
Plant Food	–1	1		Scenario Definition
Meat	–1	1		Scenario Definition
Milk	–1	1		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	68		
Livestock Fodder Intake for Milk (kg d^{-1})	55	55		
Livestock Water Intake for Meat (L d^{-1})	50	50		
Livestock Water Intake for Milk (L d^{-1})	160	160		
Livestock Soil Ingestion (kg d^{-1})	0.5	0.5		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	0		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		

Table C2-8. Parameter Values for Resident Farmer (With Irrigation) After Loss of Institutional Controls (Table 7, Scenario 2) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Translocation Factor, Leafy and Fodder	1 y	1 y		
Weathering Removal Constant	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-9. Parameter Values for Domestic Resident (Full Time) After Loss of Institutional Controls (Table 7, Scenario 5)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.5		Scenario definition
Outdoor Time Fraction	0.25	0.25		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	NA		Beyeler et al. 1998
Meat and Poultry Consumption (kg y^{-1})	63	NA		Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	.9		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	NA		Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	0		
Livestock Water	1	1		
Irrigation Water	1	1		
Aquatic Food	1	1		
Plant Food	–1	.3		Scenario Definition
Meat	–1	0		Scenario Definition
Milk	–1	0		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	NA		
Livestock Fodder Intake for Milk (kg d^{-1})	55	NA		

Table C2-9. Parameter Values for Domestic Resident (Full Time) After Loss of Institutional Controls (Table 7, Scenario 5) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Livestock Water Intake for Meat (L d^{-1})	50	NA		
Livestock Water Intake for Milk (L d^{-1})	160	NA		
Livestock Soil Ingestion (kg d^{-1})	0.5	NA		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	0		
Livestock Water	1	0		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-10. Parameter Values for Domestic Resident (Part Time) After Loss of Institutional Controls (Table 7, Scenario 6)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.15		Scenario definition
Outdoor Time Fraction	0.25	0.08		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	NA		Beyeler et al. 1998

Table C2-10. Parameter Values for Domestic Resident (Part Time) After Loss of Institutional Controls (Table 7, Scenario 6) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Meat and Poultry Consumption (kg y^{-1})	63	NA		Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	.9		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	NA		Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	0		
Livestock Water	1	1		
Irrigation Water	1	1		
Aquatic Food	1	1		
Plant Food	–1	.3		Scenario Definition
Meat	–1	0		Scenario Definition
Milk	–1	0		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	NA		
Livestock Fodder Intake for Milk (kg d^{-1})	55	NA		
Livestock Water Intake for Meat (L d^{-1})	50	NA		
Livestock Water Intake for Milk (L d^{-1})	160	NA		
Livestock Soil Ingestion (kg d^{-1})	0.5	NA		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	0		
Livestock Water	1	0		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

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